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Technical Memorandum

# MODIFICATION (XU1643U) OF THE XU1643 TRANSDUCER

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Prepared by: Pat Monahan



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## ABSTRACT

This memorandum discusses the development of the XU1643U transducer which is replacing the XU1643 transducer for use as an omnidirectional projector on active submarines and for research and ranging projects.

## ADMINISTRATIVE INFORMATION

This memorandum was prepared under Project No. A90062, "Noise Augmentation Program," Principal Investigator -- M. Fisher, Code 413. The sponsoring activity is NAVSEA, Code 63Y3-1, Project Manager -- J. Lascody.

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## INTRODUCTION

The XU1643U uses the same ceramic bimorph elements and is held in the same mounting fixture as the XU1643. Figure A shows the bimorph sandwich used in the XU1643 and XU1643U transducers. Each of these transducers uses three elements mounted in a common fixture and is referred to as a triple lollipop. Figure B shows an assembled XU1643U triple lollipop. The XU1643U is a one step, room temperature curing urethane encapsulated element with pigtails. The XU1643 is a two step, oven curing urethane encapsulation in a neoprene Jacketed metal housing equipped with watertight bulkhead connectors.

Figure A

Figure B

The complexity of the XU1643 design makes it both costly to fabricate and subject to failure. This stems mainly from the use of the metal housing which is mechanically quite different from the urethane encapsulation and neoprene jacket to which it is bonded. Figure C shows the XU1643 transducer element. An additional neoprene cover is bonded to the Face shown. Temperature and pressure changes cause stress at the metal to urethane interface. When this bond fails, seawater is free to work its way to the bulkhead connectors which shorts the element. The bulkhead connectors are hard mounted and are often broken due to handling impacts or the like.

Figure C

The XU1643U was designed to remedy the problems and simplify the fabrication of the XU1643. It is basically the same as the XU1643 but without the neoprene jacketed metal housing. The hard mounted connectors have been replaced by short pigtails which allow shock resistance, and a metal retaining ring was added for mounting purposes. The retaining ring is inside the potting but is in no way connected to the transducer element or its wiring. Figure D shows the XU1643U in its prototype mold ready for potting.

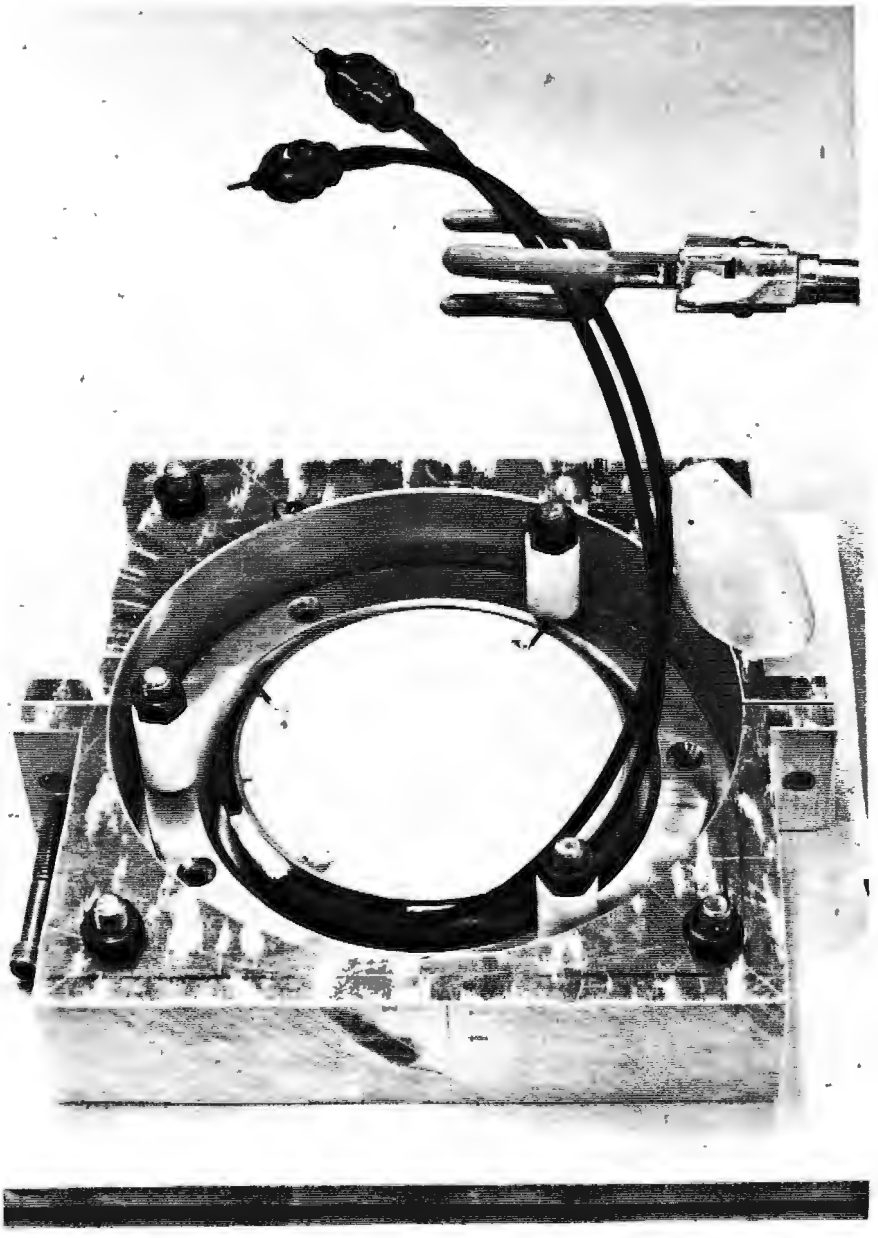


Figure D

## DATA

Since the late 1960's, the XU1643 transducer has been manufactured at NUSC, New London. The neoprene jacketed metal housing with its connector bulkhead was made in the Machine Shop, while the Transducer Model Shop was responsible for the fabrication of the ceramic bimorph, the encapsulation into the metal housing, and final transducer assembly. Other NUSC functions such as the Dodge Pond Field Station and the Hydrostatic Pressure Lab (Bldg #44) have also been involved in the ongoing testing of these units.

In 1982, 16 failed XU1643's were taken apart and reconstructed. During the first quarter of 1983, about $30,000 had been spent for the "lollipop" work in the Transducer Model Shop alone. Most of the failures have been caused by water leaking into the unit although breakage of pins and pin insulators are not uncommon occurrences. The failed units upon their return to NUSC had been completely disassembled in most cases and refabricated. The XU1643U costs 1/12 that of the XU1643 to fabricate. Fabrication time for the XU1643 and XU1643U can be seen on Table 1. In many instances new parts were used in the reassembling of these units. A considerable amount of time for this work was required of the Transducer Model Shop and the Machine Shop.

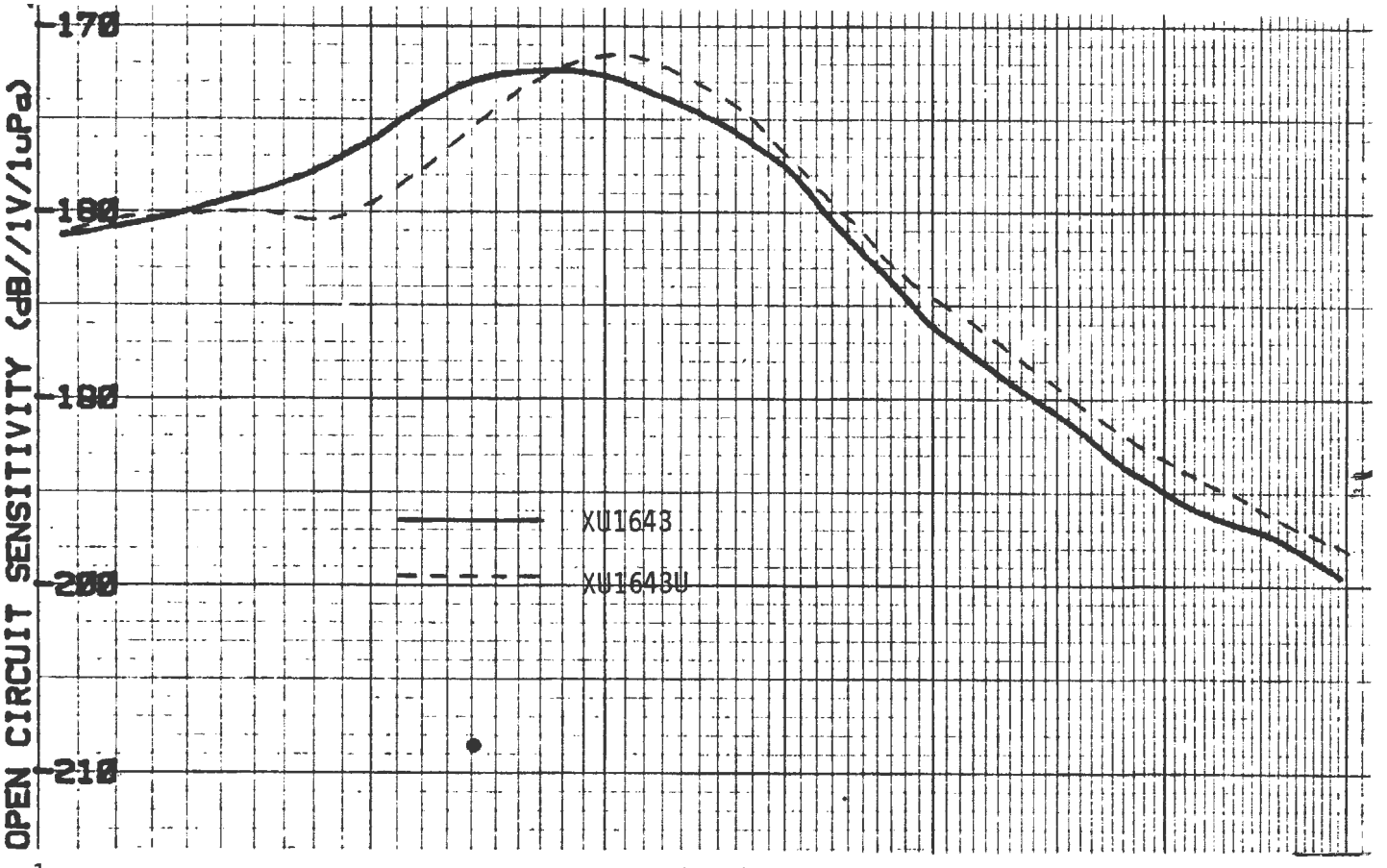
An XU1643U has successfully passed through 1000 pressure cycles of 0-650 psi and was then exposed to an accelerated life test. The unit was placed in seawater (salinity of 34 0/00) at 150°F for 103 days. An XU1643 control unit, after passing the pressure cycling test, failed during the accelerated life test due to loss of watertight integrity, resulting in low resistance readings between leads and to ground. The XU1643U, after passing these tests, was acoustically tested. The data for the XU1643U acoustic measurements is in NUSC Calibration Report No. 5230-6200.

Graph No. 1 shows a comparison of the receiving sensitivity of a typical XU1643 and the XU1643U transducers. Graph No. 2 shows a comparison of the Transit Voltage Response of a typical XU1643 and the XU1643U transducers.

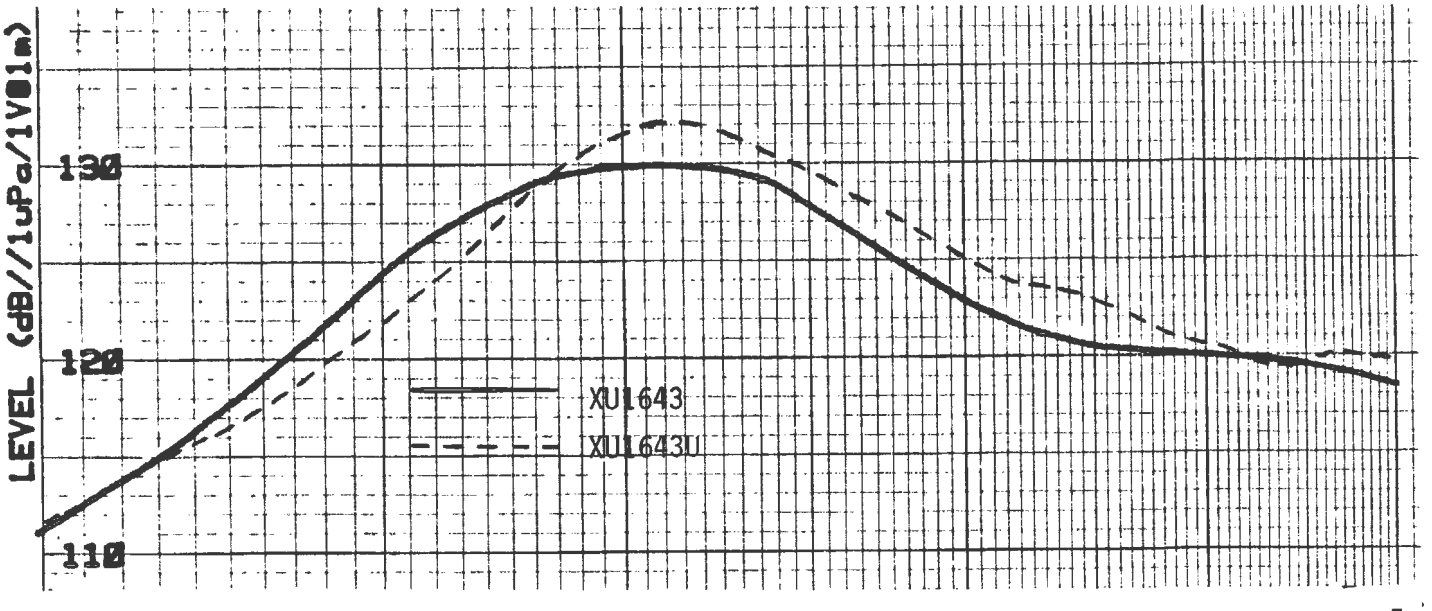
## CONCLUSION

The XU1643U can replace the XU1643 transducer with no modifications to the mounting assembly of the triple lollipop. Implementation of this modification should render a failure rate that is considerably lower in comparison to the existing transducer. Considering the labor time necessary to construct the XU1643U as compared to the XU1643, the new unit should cost about 12% of the present elements. In addition to being used for noise augmentation, the bimorph transducers are also used for various testing in other systems.

In addition to a large decrease in the cost of assembling the individual units, there should be a substantial decrease in failures resulting in considerable savings in operating system down time, shipboard maintenance, and shipping expenses.




Frequency (KHz)
Graph No. 1




Frequency (KHz)
Graph No. 2

TABLE I

FABRICATION TIME OF XU1643 and XU1643U
TRIPLE LOLLIPOPS

| XU1643 | Man Hours | XU1643U | Man Hours |
|---|---|---|---|
| 1. fabricate 3 ceramic sandwiches | 24 | 1. fabricate 3 ceramic sandwiches and attach pigtails | 28 |
| 2. fabricate 3 high hats | 72 | 2. clean, prime, and pot sandwiches, rings and pigtails | 3 |
| 3. clean, prime, and pot 3 high hats and sandwiches | 24 | | |
| Cure overnight in oven | | Cure overnight at room temperature | |
| sand cured surfaces of polyurethane | | remove from molds | 1 |
| prime rubber sheets<br>prime high hat flanges<br>pot sheets onto prepared surfaces | 12 | assemble triple lollipop | 1.5 |
| Cure overnight in oven | | | |
| put retaining rings on high hats<br>trim excess rubber<br>paint with neoprene compound | 3 | | |
| dry 1 hour | | | |
| Assemble triple lollipop | 1.5 | | |
| TOTAL | 136.5 | TOTAL | 33.5 |

Note: Figures on this table reflect actual work time as estimated by the Machine Shop, for fabrication of the neoprene jacketed metal housing; the Transducer Lab, for fabrication of the previous design; and the Chemistry Lab, for fabrication of the new design. These figures reflect only actual work time. Time charged by supervisors and test labs are not represented.

# APPENDIX A

## PROCEDURE FOR POTTING THE XU 1643U TRANSDUCER

Please read and understand this entire procedure before commencing any operation.

A. Materials

1. The following materials must be supplied at least 1 day before the potting operation is initiated.

   a. 3 bimorph sandwiches tested and acoustically matched.
   b. 3 retaining rings (NUSC Drawing No. 02861001).
   c. 6 8-inch minimum neoprene pigtails. (RMA-MP connector cable; molded neoprene; 20,000 psi mated pressure rating.)
   d. a suitable filled epoxy.
   e. a sheet of 19/64" Uralite 3140.
   f. a sheet of 21/64 Uralite 3140 if the new retaining rings (NUSC Drawing No. 02861001) are used.

2. Other materials needed:

   a. 1586 grams of Uralite 3140

      1) Description: Uralite 3140 is a low viscosity, two component urethane casting elastomer designed specifically to make flexible molds for use with thermosetting resins. Uralite 3140 mixes, pours and cures at room temperature into a tough, yet flexible mold to facilitate easy removal of intracately designed models or art objects. It does not exhibit typical moisture sensitive characteristics of most urethane elastomers.

      2)

| Properties | Value |
|---|---|
| Shore Hardness - A | 60 |
| Viscosity Mixed - cps | 3800 |
| Work Life Min, @ 77°F (25°C) 300 gm mass | 25 |
| Demolding Time - hrs @ 77°F (25°C) | 12-24 |
| Complete Cure - days @ 77°F (25°C) | 3 |
| Mix Ratio by Weight | 100-A/22-B |

      3) First Aid:
      Skin Contact: Wash with mild soap and water.
      Eye Contact: Flush thoroughly with clean, cool water and obtain physician's care.
      Inhalation: If over exposure to vapors results in discomfort, remove the affected person to clean, fresh air. If symptoms persist, contact a physician for additional care and treatment.

   b. 82.5 grams of PR 420 primer.
   c. 5 grams PR 1523 m primer.

d. Miller Stepenson MS 136 Release Agent.
e. MEK and clean rags or paper towels.
f. 3 complete molds (NUSC Drawing Nos. 02860001, 02860002, 02860003, 02860004, 02860005, 02860006, 02860007, 02860008)
g. a leveled piece of jig plate large enough to accept 3 molds.
h. Polyethylene gloves.

B. Preparation of Bimorph Sandwich for Potting

1. Cut three pigtails to 8" lengths and three to 7" lengths. Prepare the bitter ends for soldering (i.e., leave 1/4" of the lead exposed).

2. Sand the first 5" from the bitter end of each pigtail with 80 grit sandpaper. Do not touch this sanded area with your fingers or allow the pigtails to become contaminated in any way.

3. Clean the side of the sandwich well with MEK between the mesh and the leads for the outer faces. See figure 1.

4. Bond the 7" lead to the cleaned areas with a suitable epoxy. This bond should be 1" away from the mesh area and at the bitter end of the pigtail. The pigtails must be parallel to the sandwich faces. See figure 1.

   NOTE: Care should be taken to keep all protrusions from the side of the bimorph sandwich to a minimum. The clearance between the center line of the sandwich and the retaining ring is 9/32". All protrusions must have 1/16-1/8" clearance.

5. Place the prepared sandwiches in a clean, dry, dust-free environment and allow the epoxy to cure overnight.

6. Solder the 8" pigtail to the mesh located on the side of the bimorph sandwich and the 7" pigtail to the jumpers from the outer faces of the sandwich. This is to be done to all 3 sandwiches. Wear gloves. The pigtail must be parallel to the sandwich faces and exit in the same direction. See figure 1.

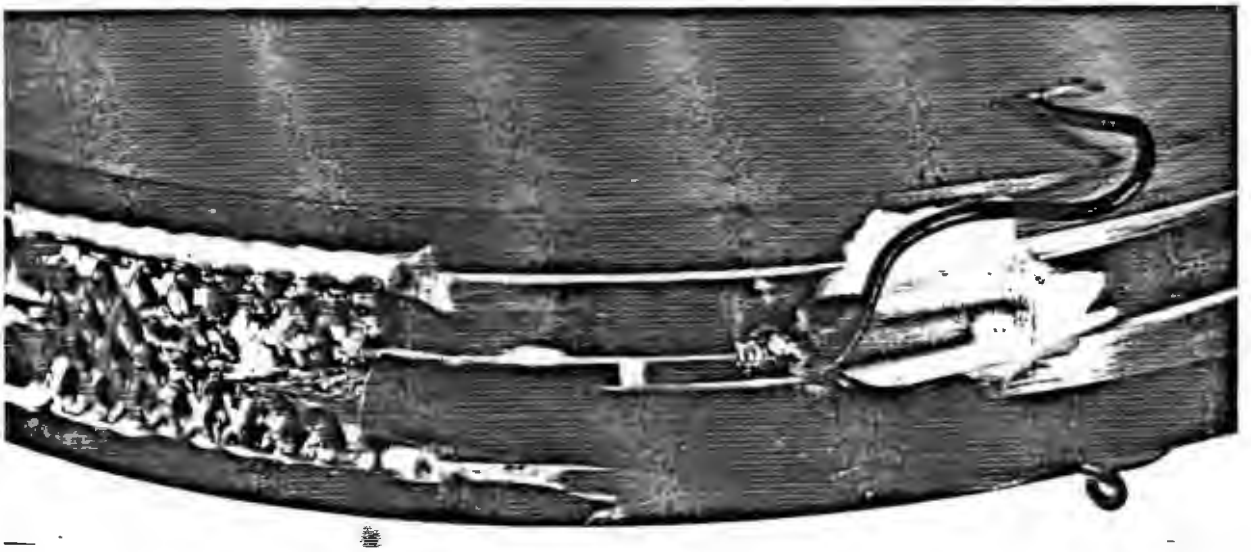


Figure 1

C. Fabrication of Uralite 3140 Spacers and their Preparation for Potting

1. Construct a mold for a 19/64" and/or 21/64" sheet and mold release it. Mix Uralite 3140 and evacuate.

   NOTE: 19/64" spacers are to be used between the sandwich and mold bottom and between the sandwich and the old retaining rings. 21/64" spacers are to be used between the sandwich and the new retaining rings.

2. Pour the Uralite into the 19/64" and/or 21/64" sheet mold. Cure overnight.

3. Remove the sheet from the mold and sand both sides with 80 grit sandpaper. Care must be taken not to remove excessive material and to maintain a flat surface. This can be done by using a belt sander while clamping the sheet at the far edge.

4. Keeping the sheet clean, cut 3/8" diameter slugs using a cork borer. Place the slugs in a dry, clean container.

5. Remove the slugs as needed (18 slugs for each triple potting) and sand the edges with 80 grit sandpaper.

6. Dust the prepared spacers with a clean, dry brush.

D. Procedure for Potting

1. Sandblast the retaining rings (80 grit).

2. Clean all pieces to be primed with MEK (i.e., retianing ring, bimorph sandwich, and pigtails).

3. Prime the retaining ring and bimorph sandwich using PR 420 and prime the neorprene pigtails using PR 1523-M. Let dry at least one hour but less than four hours.

4. While the primer is drying, inspect the molds for dings, burrs, and flash. Apply MS 136 mold release to all mold parts.

   NOTE: If pottings were made the previous day, they must be removed from the mold prior to the commencement of this step.

5. Place three prepared urethane spacers (Uralite 3140) into the mold. Lay the bimorph sandwich on the spacers in such a way that the pigtails exit the mold in a graceful, sweeping fashion. See figure 2.

6. Place the lower retaining ring spacers, threaded end down, in the molds followed by the retaining rings and the upper retaining ring spacers. Finally, snug the wind nuts to hold all pieces securely in place. See figure 2.

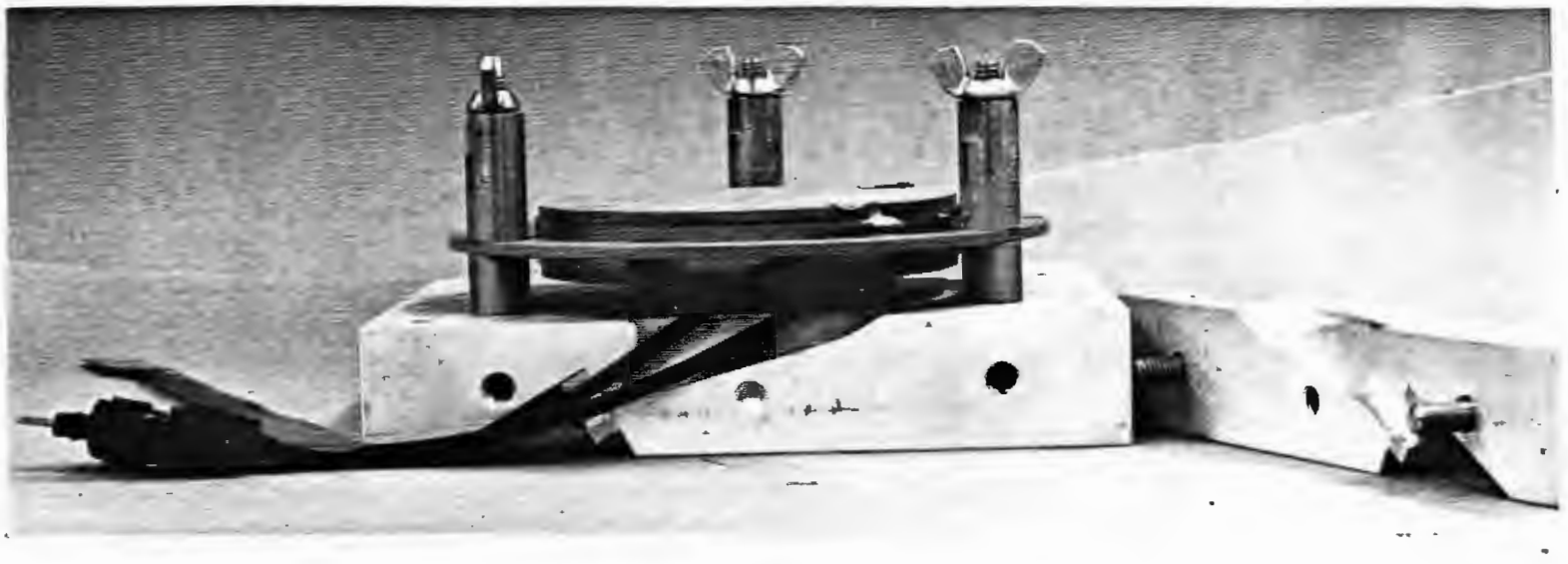


Figure 2

7. Place three prepared urethane spacers between the bimorph sandwich and the retaining ring at 120° intervals. This will ensure that the sandwich is centered in the ring. See figure 3.


Figure 3

8. Pull gently on the pigtails and tighten the pigtail retaining block. This should result in the proper 1/16" minimum clearance between the pigtails and the retaining ring and mold.

9. Complete the mold assembly.

10. Place a small tie wrap around the pigtails just outside of the pigtail retaining block.

11. Mix Uralite 3140 in a gallon can (1300 grams Part A/268 grams Part B) and evacuate.

12. Place the molds at about 3° from horizontal with the pigtails exiting toward the low side.

13. Fill the tilted molds from the low end until the undersides of the bimorph sandwiches and retaining rings are wetted.

14. Place the molds on a level surface and fill with the remaining Urethane until completely full. See figure 4.

15. Cure overnight at room temperature.

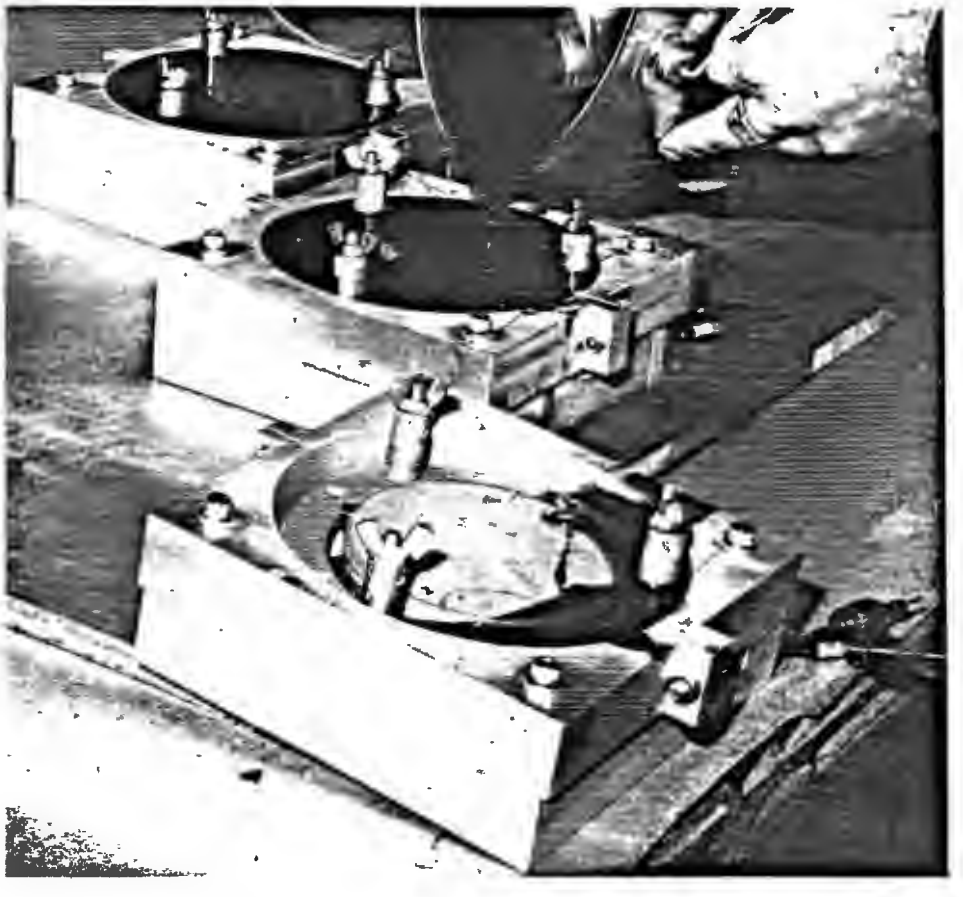


Figure 4